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JANGLE

NEVADA PROVING GROUNDS
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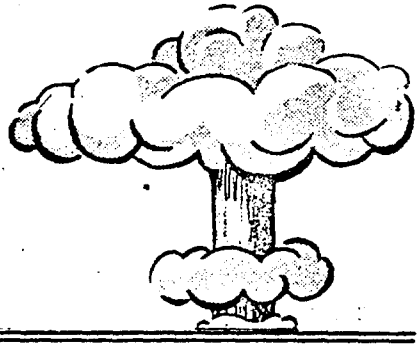
Project 2.3-2

FOXHOLE SHIELDING OF GAMMA RADIATION



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(21) Report on OPERATION JANGLE,

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(6) FOXHOLE SHIELDING OF GAMMA RADIATION,

by

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ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES

PROJECT 2.3-2

ABSTRACT

This project was designed by the Corps of Engineers to evaluate the protection afforded by foxholes against the gamma radiation emitted by atomic weapons detonated on the surface and beneath the ground. Film dosimeters were used to measure total gamma ray doses at different depths in one and two-man foxholes as well as in soil pipes sunk into the ground. The film dosimeters were contained in National Bureau of Standards' type holders and responded to gamma radiation of energy greater than 120 Kev. In the report, all doses are given in terms of roentgens and a reading of 650r (roentgens) is taken as the lethal dose; that is, the dose which will cause death to nearly 100 % of exposed personnel.

The major conclusions of this experiment, based on the data obtained in the above manner, follow:

1. Standard foxholes, as described in FM 5-15, provide excellent protection to personnel from the gamma radiation emitted during the detonation of an atomic weapon on the surface of the ground. The results show that the doses in the bottom of such foxholes located in the crosswind direction during Operation JANGLE were less than 10 per cent of the surface doses at identical locations. Since the foxholes were located outside of the major fall-out pattern, the complete dose measured was due to scattered prompt radiation. If the foxholes had been located downwind, however, the doses would have been higher, since fall-out into the foxhole and scattered radiation from the contamination on the surface would contribute more significantly to the total dose. There are indications that these contributions will not materially change the per cent of surface-received radiation reaching trained personnel in the bottom of the foxholes. An increase of surface contamination will increase the surface dose as well as the dose at the bottom of the foxhole, thereby maintaining the ratio between the two. The contaminated matter that falls into the foxhole can easily be removed by occupying personnel before it has time to increase the doses received to any great extent.

2. Except in those areas covered by extensive fall-out, foxholes also provided effective shielding in the case of the underground detonation of Operation JANGLE. The doses at the bottom of the foxholes varied from about 24 to 38 per cent of the surface doses at distances greater than 2500 feet from the burst. A great portion of this

dose, about 90 per cent, was obviously due to radioactive matter that fell into the foxhole, because the doses measured in the holes during the surface shot were approximately 10 per cent of those measured during the underground shot of identical yield. It is expected that both bursts contributed equally to the doses as far as prompt radiation is concerned.

3. The doses obtained from the detonation of atomic weapons on the surface or underground receive contributions from prompt gamma radiation, radiation emanating from column and cloud, and from residual activity due to fall-out of radioactive matter. No base surge activity was evident.

4. The complete doses at the bottom of the foxholes after the surface burst of this operation were attributable to scattered prompt radiation in addition to a small contribution from the column and cloud; no material contribution from fall-out or residual activity was evident. This lack of effect undoubtedly resulted from the location of the foxholes in the crosswind direction. If the foxholes had been located downwind, there would have been a material contribution from fall-out and residual activity. It is not expected that this would falsify the conclusions drawn in this report on the effectiveness of foxholes as protection for personnel against gamma radiation. (See conclusion 1, above.)

5. The major portion of the total dose measured at the bottom of the foxholes after the underground burst apparently came from fall-out matter in the foxhole. Contamination on the surface of the ground surrounding the foxhole contributed only about 10 per cent to the doses at the bottom of these structures, and prompt radiation could not contribute more than evidenced in the surface burst since both weapons were the same size. Yet, in all cases the doses were considerably higher during the underground detonation, leading to the obvious conclusion that matter falling into the foxholes played the most important role. Also, the doses in the two and one-man foxholes were equal, although the two man foxhole had twice the opening area. If the column or cloud activity contributed greatly to these doses, it could be expected that the doses in the two-man foxhole would be about twice as great as those in the one-man structure.

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TABLE 3.1

Distribution of Gamma Radiation in Foxholes (Surface Burst)

Range (ft)	Location	Two-man Foxhole			One-man Foxhole		Soil Pipe
2000	36" Above Surface		800 r				
	Surface		700				
	16" Below Surface	230	205	415			
	32" Below Surface	24	58	136			
	48" Below Surface	12.8	22	62			
2500	36" Above Surface		230 r				
	Surface		220				
	16" Below Surface	35	60	85			
	32" Below Surface	7	15	26			
	48" Below Surface	4	8.5	13.3			
3000	36" Above Surface		110 r				73 r
	Surface		90			55	
	16" Below Surface	23	36	55	6.8	6.6	10
	32" Below Surface	7.6	12.4	19.4	2.5	2.4	0.5
	48" Below Surface	2.5	4.8	6.7	1.6	1	0
3500	36" Above Surface		41 r				
	Surface		---				
	16" Below Surface	3	---	9.7			
	32" Below Surface	1.6	2.8	3.4			
	48" Below Surface	.54	.99	1.9			
4000	36" Above Surface		17 r				17 r
	Surface		9.6			---	
	16" Below Surface	1.6	3	5.6	---	0.35	---
	32" Below Surface	0.6	1.12	1.62	---	---	0.17
	48" Below Surface	---	0.54	0.57	0.39	---	---
4500	36" Above Surface		9.8 r				
	Surface		4.6				
	16" Below Surface	1	1.8	3.5			
	32" Below Surface	0.5	0.7	1.04			
	48" Below Surface	0.21	0.4	0.57			
5000	36" Above Surface		4.8 r				
	Surface		2.7				
	16" Below Surface	0.6	0.99	2.95			
	32" Below Surface	0.3	0.5	0.75			
	48" Below Surface	0.17	0.2	0.38			

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TABLE 3.2

Distribution of Gamma Radiation in Foxholes (Underground Burst)

Range (ft)	Location	Two-man Foxhole			One-man Foxhole		Soil Pipe
2000	36" Above Surface		3850 r				
	Surface		2300				
	16" Below Surface	1150	--	800			
	32" Below Surface	700	1000	555			
	48" Below Surface	200	200	200			
2500	36" Above Surface		1000 -- 550 r				
	Surface		78				
	16" Below Surface	78	98	115			
	32" Below Surface	43	56	50			
	48" Below Surface	73.4	94	96			
3000	36" Above Surface		175 r				155 r
	Surface		103			75	
	16" Below Surface	30	42	37	20	--	7
	32" Below Surface	22	23	20	15	11	3
	48" Below Surface	43.5	45	54	41	38	3
3500	36" Above Surface		--				
	Surface		48				
	16" Below Surface	12	17	15			
	32" Below Surface	9	10	9			
	48" Below Surface	15	15	22			
4000	36" Above Surface		32 r				28 r
	Surface		22			14	
	16" Below Surface	6	7	15	7	4	2
	32" Below Surface	5	3.4	7.2	3.7	2.8	0
	48" Below Surface	6	8.4	8.6	5	9.8	1.1
4500	36" Above Surface		22 r				
	Surface		10				
	16" Below Surface	4	5	5			
	32" Below Surface	5.8	2.8	2.8			
	48" Below Surface	--	7.7	8.9			
5000	36" Above Surface		73 r				
	Surface		23				
	16" Below Surface	15	15	67			
	32" Below Surface	21.5	22.6	15			
	48" Below Surface	--	21	19			